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Ch-16

STANDING WAVES IN A TUBE I
SPEED OF SOUND IN AIR
(or The Hotter it is the Faster it Goes)

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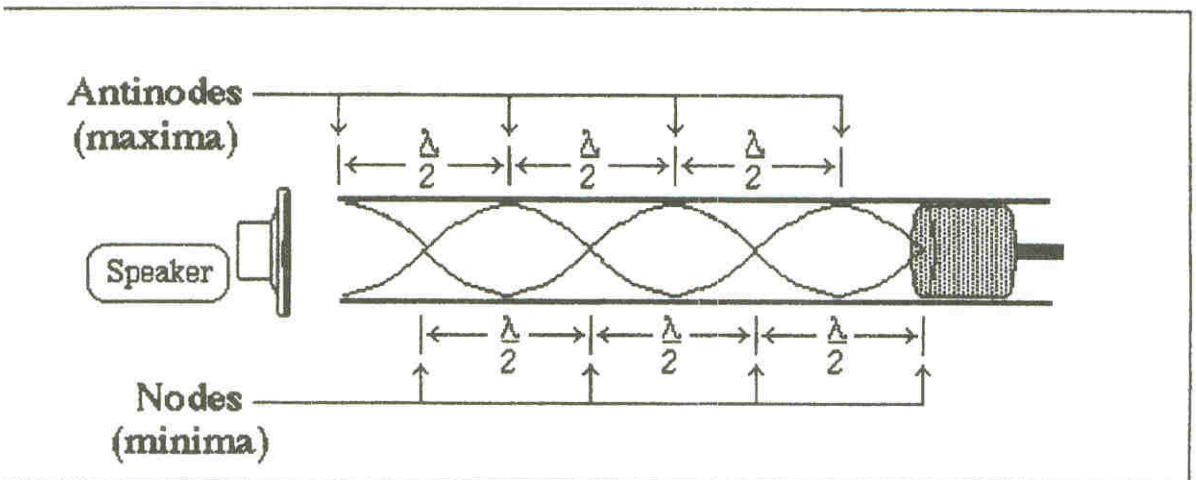
NAME: ________________________________

**** **You will have to go to the Biology lab so it will be quite enough to do this lab.**

BACKGROUND : One can excite the column of air in a tube by placing a small speaker at one end of the tube. Under conditions of resonance, standing waves will be established. If the frequency and wavelength are known, the speed of the wave can be found using the formula $\mathbf{v = f\lambda}$, where **v** is the speed, $\boldsymbol{\lambda}$ is the wavelength, and **f** is the frequency. This relationship is true for all waves.

The antinodes in a standing wave are one-half wavelength apart. Likewise, the nodes in a standing wave are one-half wavelength apart. This is true for a tube open on both ends and for a tube closed on one end and open on the other. In this experiment we are going to use the latter (open on one end and closed on the other). Examine the illustration below.



PURPOSE:

We will experimentally determine the wavelength of sound in air. Our procedure will enable us to determine both the wavelength and the frequency of a sound wave. With this we can calculate the speed of sound in air.

SET UP:

-Connect the *Timer* to the *Sound Tube* circuit board with a telephone cable.

-Connect the *Controller Box* to the *Sound Tube* circuit board. The connector attaches the three-wire jack. The wires extend away from the electronic printed circuit board.

-Have a thermometer available to record room air temperature. Familiarize yourself with the electronic board attached to the tube. The adjustment in the lower left corner is the sound volume. The micro-ammeter detects sound level at a tiny microphone mounted on the underside of the electronic board. A hole in the side of the tube allows the microphone to extend into the tube. A small blue switch box allows the selection of the frequency range. Use only one numbered switch pushed to **ON** at a time.

-Put the number 2 switch in the **ON** position.

-The *Controller Box is* used *for* coarse and fine adjustment of frequency after the range has been established with the small switches.

Timer Settings:

Blue Decimal: XXXX. s (The meter will read *in* hertz)
Brown SWITCH: 00 Not Used
Green MODE: 11 FREQ METER

PROCEDURE:

Note: To read the frequency of the sound being produced by the speaker, push and release the black reset button on the Timer. Adjust the frequency to about 1000 Hz. After each adjustment, you must push the black reset button on the Timer to read the frequency. Slowly, move the plunger in and out while watching the meter. The meter will move to alternating minima and maxima. When the meter is reading at a minimum, the microphone detects a node. Conversely, when the meter reads a maximum, the microphone detects an antinode. Your task is to locate four consecutive minima or four consecutive maxima (one or the other, not both) at a constant frequency. Minima are usually easier to detect.

1. Record the centimeter locations of four consecutive minima at a frequency of about 1000 Hz by starting with the plunger in and slowly pulling it out. These are designated **P** for position.

2. Repeat step 1 for frequencies of about 2000 Hz, 2500 Hz, and 3000 Hz. (Remember, frequencies above 2000 Hz will require changing the frequency range switch from 2 to 3 or 4 to the ON position.)

DATA and CALCULATIONS: Room Temperature = ________________________ ^{o}C

Frequency (Hz)	P Consecutive Max/Min (cm)	$\Delta P = \lambda/2$ (cm)	$2(\Delta P) = \lambda$ (cm)	λ (m)	v (m/s)
				Average Velocity	

ANALYSIS:

1. Note and record the positions, **P**, of minima (or maxima) and enter these in the **P** column of your table. Calculate the difference between consecutive minima, and record in the **ΔP** column. These should be nearly the same for each frequency and are equal to one-half wavelength, **λ/2**.

2. Double the values of the **ΔP** column to obtain A, then convert these to meters. Record in the table.

3. Use the equation **v = f λ** to calculate the values of **v**. the table. Record in the table.

4. Average these experimental values of **v** to compare with the value of the speed of sound in air.

5. The speed of sound in air is 332 m/s at 0 ^{o}C and the speed increases by 0.59 m/s for each degree Celsius above zero. Calculate and record the speed of sound in your lab room.

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6. Determine the percent difference between the calculated value and the experimental value of the speed of sound.

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QUESTIONS:

1. With air temperature at 22°C, a track meet starter fires his gun. If you hear the sound 0.35 seconds after the flash of the gun, how far away is the starter?

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2. If you hear thunder 3.0 seconds after a lightning flash, how far away was the flash? Air temperature is 25°C.

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3. Approximately, how far does sound travel in one second? (in miles) 5,280 ft = 1 mile

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4. How long will it take sound to travel one mile?

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